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EVALUATION OF THE OUTFLOW METER AS A MEASUREMENT OF PAVEMENT TEXTURE

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Division of Research & Development

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16. Abstract

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The purpose of this investigation was to evaluate the Outflow Meter and to correlate it with skid resistance measurements. The Outflow Meter performs adequately, with a few minor problems and correlates fairly well with the sand patch texture measurement devices. It does not appear to correlate well with any of the skid resistance measurements.

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ABSTRACT

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EVALUATION OF THE OUTFLOW METER AS A MEASUREMENT OF PAVEMENT TEXTURE

PROJECT PURPOSE:

The purpose of this investigation was to field evaluate the outflow meter as a measurement device for pavement surface texture and to correlate the outflow meter data with pavement skid resistance measurements.

The six pavement sites chosen for this evaluation were selected because of the range of skid numbers indicated in the 1977 skid inventory and because of the variety of aggregates and gradations used in construction.

TEST SITES:

Site No. 1 is a six lane, 55 mph, divided Interstate highway built during 1974 and currently has an ADT rate of 27,500 vehicles. The surface course is a fine aggregate bituminous concrete mix #5 (gradation specification attached, Appendix A) using a trap rock coarse aggregate which has a history of providing good skid resistance.

Site No. 2 is a four lane, 45 mph, state highway which was overlaid in 1976 using a crushed gravel coarse aggregate in a mix #4. This roadway has an ADT of 11,900 vehicles.

Site No. 3 is a four lane, 50 mph, 30,000 ADT, divided state highway built in 1971 using a mix #5 gradation with carbonate rock coarse aggregate. This aggregate has a history of being polish prone and has been banned from use in the surface course for several years.

Site No. 4 is a four lane, 50 mph, divided state highway carrying 18,900 vehicles per day. It was also built in 1971 using the same aggregate supplier as that of Site No. 3 and using the same mix #5 gradation. The surface texture, however, looks radically different.

Site No. 5 is a six lane, divided, 55 mph, 12,400 ADT, Interstate highway built in 1974 with portland cement concrete. The surface was broom finished during construction but little texture remains in the wheelpaths.

Site No. 6 is a four lane, divided, 55 mph, state highway with an ADT of 17,000 vehicles. It was built in 1975 using the same aggregate and gradation as found on Site No. 1.

TEST PROCEDURE:

Four traffic cones were placed at approximately 300' intervals along the test site. Skid tests were performed at 30, 40, and 50 mph locking the test wheel at each traffic cone. Two locations were marked in the locked wheel path near each of the four cones. Five outflow meter measurements, five British Portable skid tests and one modified sand patch measurement was made on each of these locations. The ambient, surface and water temperatures were recorded at each site. A tabulation of the raw data for both

spring and fall measurements is attached (Appendix B). Please note that the sand patch results from the spring set of measurements have been changed. It was recently discovered that the texture depth shown in the interim report were for Australian sand rather than for C109 sand.

OUTFLOW METER MEASUREMENTS:

For each of four of the test sites (1,2,4&6), the overall average outflow reading for the fall test series was within two seconds of the average value recorded in the spring. Also, all four of these test sites had overall average flow times less than 25 seconds with the range of average flow times being less than 30 seconds for any one site. The remaining two sites (3&5) had overall average differences between the spring and fall measurements of 29 and 42.6 seconds respectively. The range of the average measurements for each site was 288 and 162 seconds respectively.

These results indicate that when the flow times are short the repeatability improves and the range of average measurements on a site is decreased. The first reading on a particular location is usually lower than the remaining four which generally increase a few tenths of a second per test.

EQUIPMENT PROBLEMS:

On several occasions the timer on the outflow meter failed to start as the water level dropped below the upper probe. This was found to be due to a poor contact at one of the jack connections,

usually the ground jack. The timer was also observed to start approximately one to two seconds after the water level had dropped below the upper probe. This "late start"was not noticed until the fall measurements were being taken and may account for some of the variability on a particular location if it had gone unnoticed during earlier measurements.

The operating procedures provided with the outflow meter were sufficient for proper operation. Procedures for care of the equipment were not supplied.

SAND PATCH MEASUREMENTS:

Modified sand patch measurements were made with a 2"x4"x½" deep aluminum plate using ASTM C109 sand. The average texture depth arrived at through the sand patch measurements seems to correlate fairly well with the outflow meter results (Figure 1).

SKID RESISTANCE MEASUREMENTS:

Speed gradients, average SN_{40} skid measurements and average British Portable Test measurements all appear to have similar relationships with the average outflow meter results. (Figures 2, 3,4). Site No. 4 results, at first glance, would seem to be outliers relative to these relationships. However, this is not considered to be the case. As mentioned earlier sites 3&4 were built during the same year using the same gradation and the same polish prone coarse aggregate. Both the outflow meter and the sand patch indicate that Site 3 has little if any texture. The skid test results show

that it has poor skid resistance. Site 4, on the other hand, has the same level of skid resistance but it exhibits very good surface texture. Perhaps this suggests that a correction between pavement texture and skid resistance may not be as meaningful as was hoped for.

CONCLUSIONS - RECOMMENDATIONS

The outflow meter appears to be a good test method for determining surface texture. Although no formal analysis is included it does appear to correlate with the sand patch procedure. The main course of variability within a pavement section is the positioning of the meter on the pavement section. Care must be taken in selecting a representative sample location. Perhaps increasing the number of sample locations on a pavement section and eliminating the highest and lowest sample results would help reduce this source of variability.

The problem of the counter not starting due to a poor connection could be eliminated by replacing the plug-in type connectors.

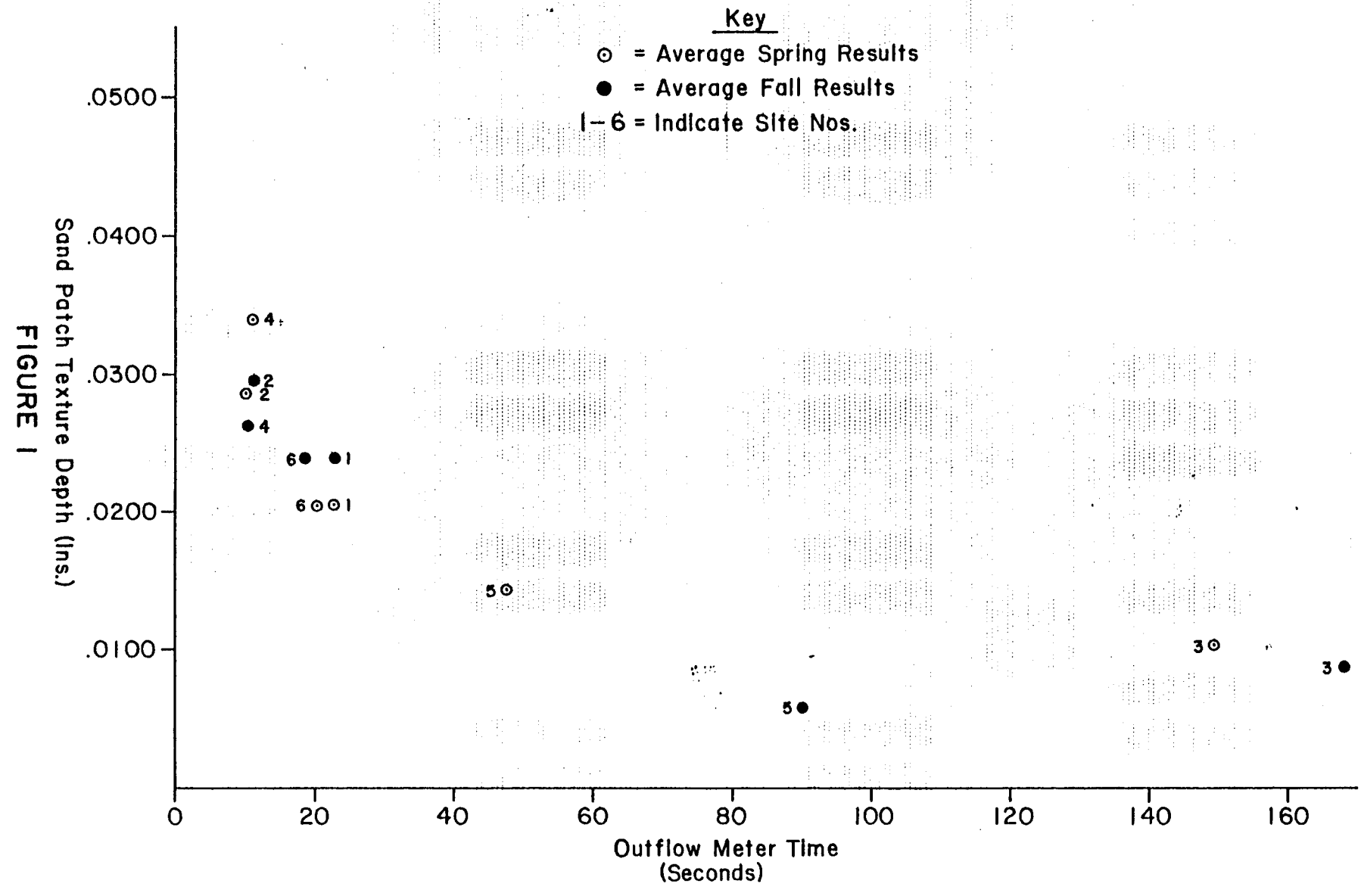
Key
⊙ = Average Spring Results
● = Average Fall Results
1–6 = Indicate Site Nos.
.0500
.0400
.0300
.0200
.0100
Sand Patch Texture Depth (Ins.)
0
20
40
60
80
100
120
140
160
Outflow Meter Time
(Seconds)

FIGURE 1

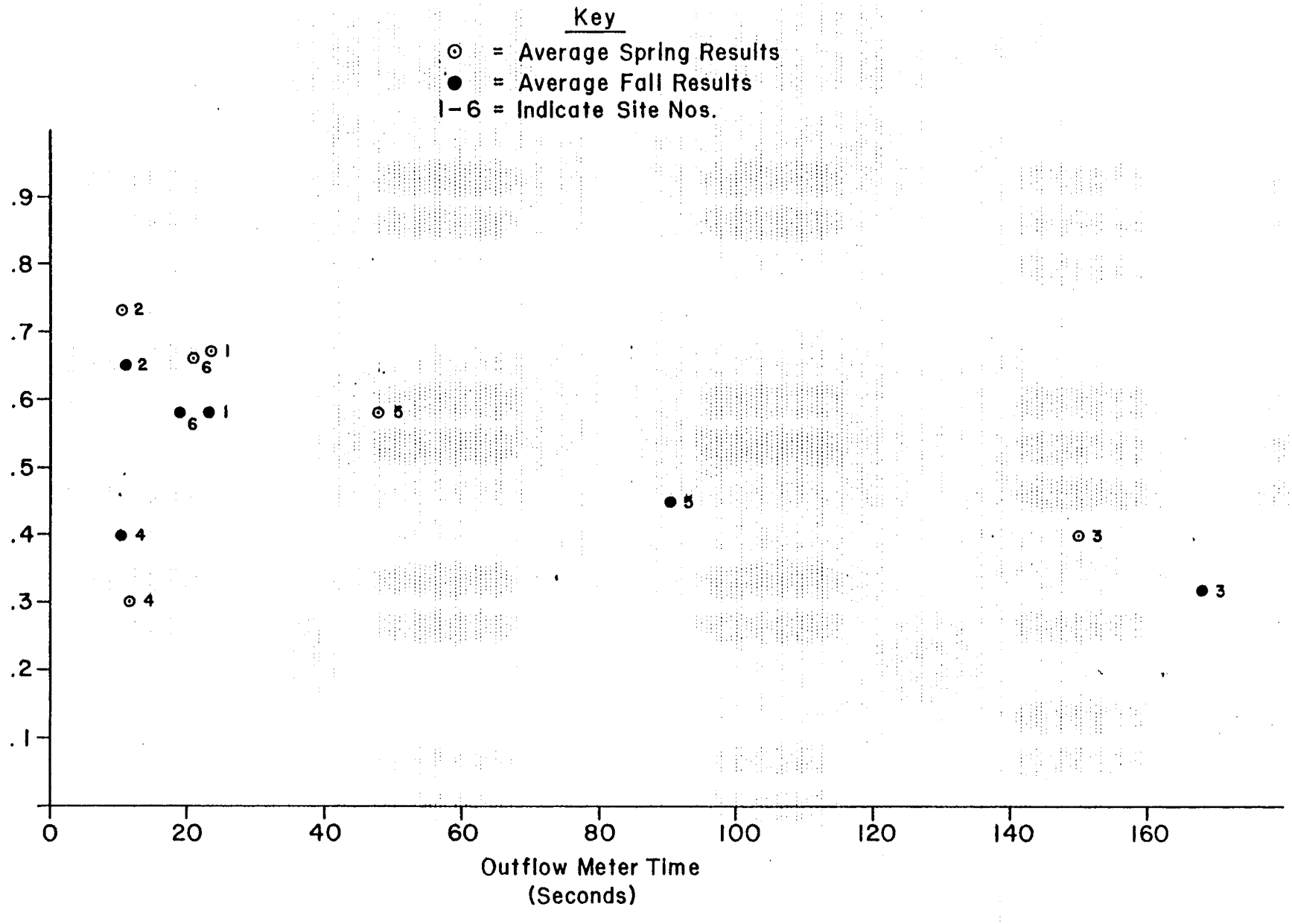
Key
⊙ = Average Spring Results
● = Average Fall Results
1-6 = Indicate Site Nos.
Speed Gradient
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
20
40
60
80
100
120
140
160
Outflow Meter Time
(Seconds)

FIGURE 2

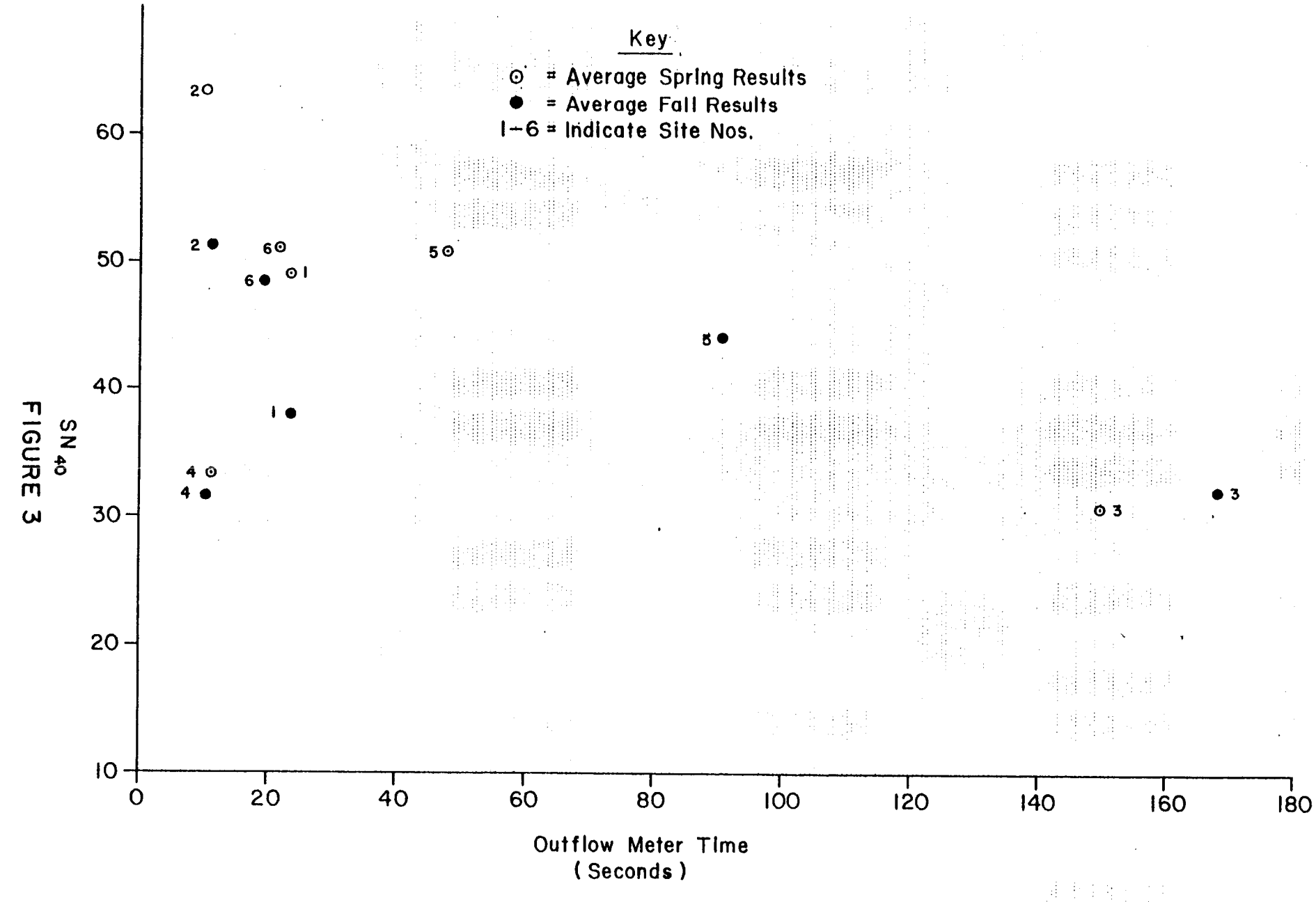
Key
⊙ = Average Spring Results
● = Average Fall Results
1–6 = Indicate Site Nos.
SN 40
Outflow Meter Time
(Seconds)
10
20
30
40
50
60
0
20
40
60
80
100
120
140
160
180
20
2 ●
6 ⊙
6 ● ⊙ 1
5 ⊙
5 ●
1 ●
4 ⊙
4 ●
⊙ 3
● 3

FIGURE 3

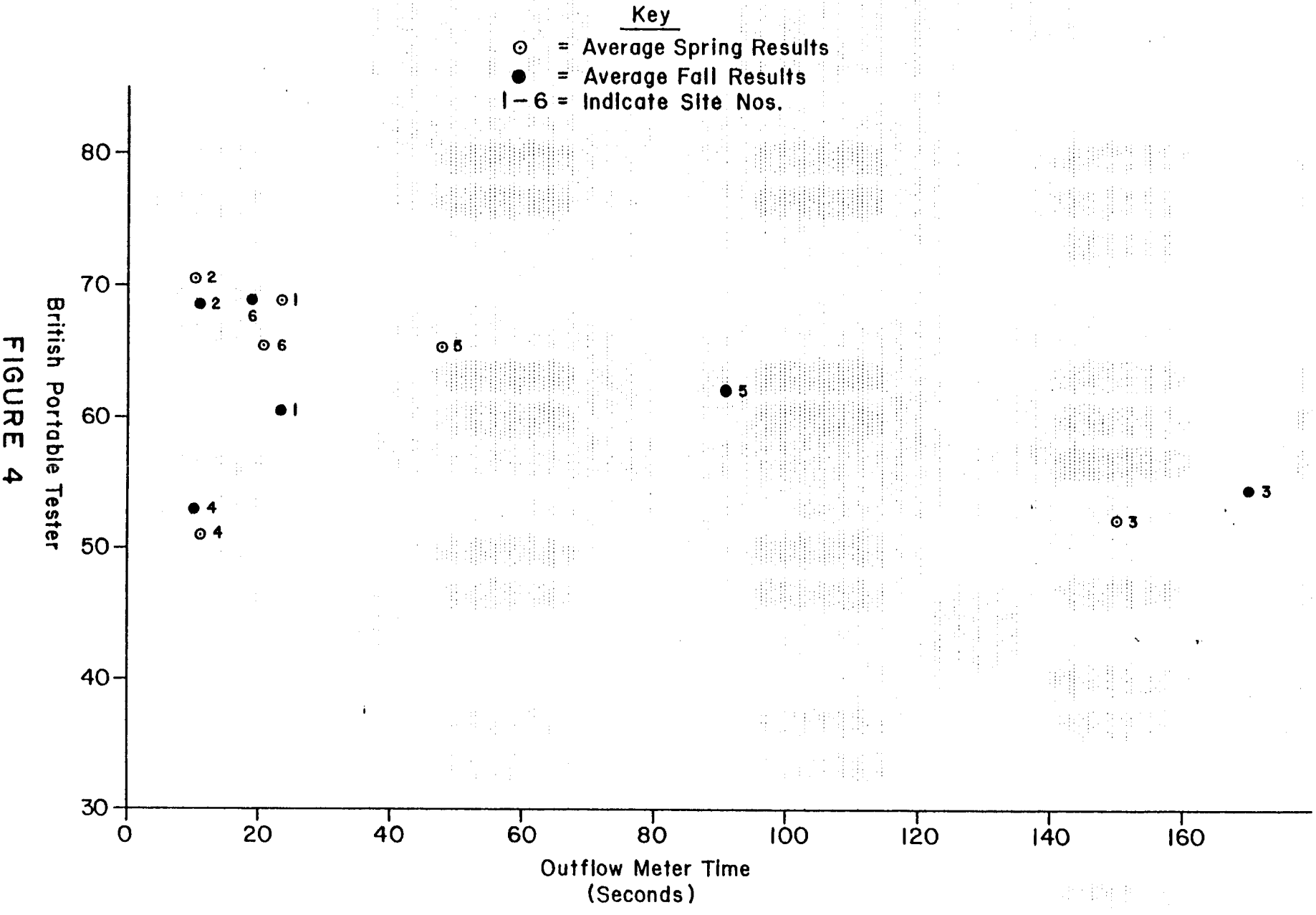
Key
⊙ = Average Spring Results
● = Average Fall Results
1–6 = Indicate Site Nos.
British Portable Tester
Outflow Meter Time
(Seconds)
80
70
60
50
40
30
0
20
40
60
80
100
120
140
160

FIGURE 4

APPENDIX A

Gradation Specifications

for

Bituminous Mixtures and

Concrete Pavement Specifications

Used in

Outflow Meter

Test Sites

FORMULA FOR JOB MIX. THE PROVISIONS PERTAINING TO JOB MIX FORMULA AND ITS APPLICATION SHALL BE AS SPECIFIED FOR MIX NO. 1 UNDER HOT-MIXED BITUMINOUS CONCRETE IN ART. 3.10.2.

SECTION 10

BITUMINOUS CONCRETE SURFACE COURSE, HOT-MIXED

3.10.2. MATERIALS.

THAT PORTION OF THE FOURTH AND FIFTH PARAGRAPHS OF THIS ARTICLE OF THE STANDARD SPECIFICATIONS WHICH REFERS TO NO. 10 SIEVE IS AMENDED TO READ NO. 8 SIEVE.

THE FIRST PARAGRAPH, INCLUDING THE TABULATION THEREOF, ON PAGE 168 OF THE STANDARD SPECIFICATIONS IS CHANGED TO READ AS FOLLOWS:

COARSE AGGREGATE FOR THE VARIOUS TYPES AND MIXTURES SHALL CONFORM TO THE REQUIREMENTS OF ART. 8.5.5, EXCEPT THAT THE GRADATION NEED NOT CONFORM TO TABLE 28 UNDER ART. 8.5.4.

THE LAST SENTENCE IN THE SIXTH PARAGRAPH ON PAGE 168 OF THE STANDARD SPECIFICATIONS IS CHANGED TO READ AS FOLLOWS:

IN CALCULATING THE PERCENTAGES OF AGGREGATES OF THE VARIOUS SIZES, THE BITUMINOUS MATERIAL IS EXCLUDED.

THE LAST PARAGRAPH ON PAGE 168 OF THE STANDARD SPECIFICATIONS IS DELETED.

THE FOLLOWING IS ADDED TO THIS ARTICLE OF THE STANDARD SPECIFICATIONS:

IN THE FOLLOWING TABLES, THE VARIOUS BITUMINOUS CONCRETE COURSES SHALL BE CONSTRUCTED WITH THE MIX NUMBERS AS SHOWN BELOW:

COURSE	MIX NO.
BITUMINOUS STABILIZED BASE (STONE OR GRAVEL MIX)	1
ALL BOTTOM COURSES	2
CA-BC-1 AND CA-BC-2, TOP	3
MA-BC-1 AND MA-BC-2, TOP	4

FA-BC-1 AND FA-BC-2, TOP 5

SP-1 AND SP-2, TOP 6

TABLE 3 ON PAGE 169 OF THE STANDARD SPECIFICATIONS IS CHANGED TO READ AS FOLLOWS:

TABLE 3. BITUMINOUS CONCRETE MIXTURES

GRADATION MIX NO.	1	2	3	4	5	6
SIEVE SIZE	GRADING OF TOTAL AGGREGATE (COARSE PLUS FINE, PLUS FILLER IF REQUIRED). AMOUNTS FINER THAN EACH LABORATORY SIEVE (SQUARE OPENING), WEIGHT PERCENT.					
2"	100	---	---	---	---	---
1-1/2"	90-100	100	---	---	---	---
1"	80-100	90-100	100	---	---	---
3/4"	---	---	90-100	100	---	---
1/2"	50-85	60-80	---	90-100	100	---
3/8"	---	---	60-80	---	80-100	100
NO. 4	25-60	25-60	35-65	40-70	55-75	80-100
NO. 8	20-50	15-45	20-50	25-55	30-60	65-100
NO. 16	---	---	---	---	---	40-80
NO. 30	---	---	---	---	---	20-65
NO. 50	8-30	3-18	8-25	10-25	10-30	7-40
NO. 100	---	---	---	---	---	5-20
NO. 200	4-12	1-7	4-10	4-10	4-10	4-10
	ASPHALT CEMENT, WEIGHT PERCENT OF TOTAL MIXTURES					
	3.5-8	4-8.5	4-9	4.5-9.5	5-10	7-12

NOTE: MATERIAL PASSING THE NO. 200 SIEVE MAY CONSIST OF FINE PARTICLES OF THE AGGREGATE OR MINERAL FILLER, OR BOTH. MATERIAL PASSING THE NO. 40 SIEVE SHALL BE NONPLASTIC WHEN TESTED IN ACCORDANCE WITH THE REQUIREMENTS OF CURRENT A.A.S.H.O. DESIGNATION T 90.

THE FOLLOWING IS ADDED TO THIS ARTICLE OF THE STANDARD SPECIFICATIONS:

Concrete. Concrete for bridge decks, including deck slabs, curbs, sidewalks and parapets, shall be air-entrained. The requirements for air-entrained concrete, air-entraining additives and air-entraining admixtures shall be as specified in Art. 3.12.2.

The classes of concrete required for the various items of work shall be Class A, B, C or D for standard concrete and Class B-1, C-1 or D-1 for high early strength concrete, as prescribed in the Plans or Specifications, and shall be proportioned as shown in Table 7 except that, when the coarse aggregate has a percentage of voids above or below 45, the volume of coarse aggregate or fine aggregate, respectively, shall be decreased so that the volume of the coarse aggregate voids will equal 90 per cent of the fine aggregate volume.

Voids shall be determined by the requirements of current A. A. S. H. O. Designation T20, except that the specific gravity shall be that of saturated surface dry material. The unit weights of aggregates shall be determined on surface dry material in accordance with the requirements of current A. A. S. H. O. Designation T 19, except that the cubic foot measure shall have an inside diameter of 10.5 inches and an inside height of 20 inches. For aggregates with maximum size larger than 1¼ inches, the measure may be the 8-foot cube in accordance with Article 9.1.2. The cement and aggregates for all concrete shall be proportioned by volume as hereinafter provided and shall be measured and batched by weight as specified in Art. 3.12.3.

The unit weight of coarse aggregate will be determined as specified in Art. 9.1.2, "Method of Test for Unit Weight of Coarse Aggregate (Dry Loose Measure)."

Table 7.—Concrete Proportioning

Class	Cement, Cubic Feet (Bags)	Fine Aggregate, Cubic Feet	Coarse Aggregate, Cubic Feet	Void Content, Coarse Aggregate Cubic Feet
A	1	1.50	3.0	1.350
B	1	1.75	3.5	1.575
C	1	2.00	4.0	1.800
D	1	2.25	4.5	2.025
B-1	1	1.40	2.80	1.260
C-1	1	1.60	3.20	1.440
D-1	1	1.80	3.60	1.620

APPENDIX B

Tabulation of Data Collected at Outflow Meter Test Sites

OUTFLOW METER EVALUATION

Date May 1, 1978 Site No. 1

Route I-295 Direction South Milepost 70.5 - 70.2

Year Placed 1974 Lanes (One-way) 3 AADT 27,500

Pave. Type Bituminous Concrete Mix No. 5 (FABC) Coarse Aggregate Trap Rock

Ambient Temp. 62°F Surface Temp. 69°F Water Temp. 58°F

OUTFLOW METER TESTS
Time (Seconds)

No.	1	2	3	4	5	6	7	8
1	20.81	10.40	28.38	17.69	32.10	19.23	28.54	20.99
2	21.47	10.93	28.68	18.21	33.35	19.72	29.45	21.43
3	21.39	10.81	28.80	18.54	34.18	20.65	29.87	21.96
4	21.74	11.15	29.49	18.92	35.10	21.20	30.80	22.49
5	22.38	10.99	29.53	19.27	35.13	21.68	30.49	22.93
Avg.	21.56	10.86	28.98	18.53	33.97	20.50	29.83	21.96

BRITISH PORTABLE TESTS

No.	1	2	3	4	5	6	7	8
1	65	73	69	67	63	71	70	68
2	67	74	67	68	68	72	66	67
3	66	73	70	70	68	73	70	66
4	68	69	71	67	66	70	70	66
5	68	72	70	69	69	71	70	67
Avg.	66.8	72.2	69.4	68.2	66.8	71.4	69.2	66.8

SAND PATCH TESTS

Loc.	1	2	3	4	5	6	7	8
Texture Depth (inches)	.0210	.0202	.0197	.0175	.0184	.0252	.0188	.0248

SKID TESTS

	30 MPH	40 MPH	50 MPH
1	56	49	43
2	65	53	52
3	59	49	43
4	55	45	42
Avg.	58.75	49	45

OUTFLOW METER EVALUATION

Date May 2, 1978 Site No. 2

Route 31 Direction North Milepost 4.2 - 4.5

Year Placed 1976 Lanes (One-way) 2 AADT 11,900

Pave. Type Bituminous Concrete Mix No. 4 (MABC) Coarse Aggregate Crushed Gravel

Ambient Temp. 54°F Surface Temp. 71°F Water Temp. 60°F

OUTFLOW METER TESTS
Time (Seconds)

No.	1	2	3	4	5	6	7	8
1	13.44	16.32	7.46	10.90	9.00	7.36	8.63	6.78
2	13.49	16.64	7.61	11.13	9.04	7.54	8.62	6.97
3	13.55	16.79	7.67	11.18	9.14	7.69	8.67	7.01
4	13.65	17.03	7.64	11.20	9.26	7.81	8.60	6.99
5	13.66	17.12	7.65	11.31	9.25	7.85	8.67	7.11
Avg.	13.56	16.78	7.61	11.14	9.14	7.65	8.64	6.97

BRITISH PORTABLE TESTS

No.	1	2	3	4	5	6	7	8
1	70	66	72	72	66	73	69	74
2	68	67	73	74	66	75	68	75
3	67	67	71	72	65	76	68	75
4	68	67	71	70	66	76	69	75
5	70	67	70	72	67	75	69	76
Avg.	68.6	66.8	71.4	72	66	75	68.6	75

SAND PATCH TESTS

Loc.	1	2	3	4	5	6	7	8
Texture Depth (inches)	.0193	.0099	.0295	.0321	.0239	.0273	.0412	.0439

SKID TESTS

	30 MPH	40 MPH	50 MPH
1	69	62	-
2	72	64	-
3	74	64	55
4	72	64	59
Avg.	71.75	63.5	57

OUTFLOW METER EVALUATION

Date May 3, 1978 Site No. 3

Route 206 Direction South Milepost 37.1 - 36.8

Year Placed 1971 Lanes (One-way) 2 AADT 30,000

Pave. Type Bituminous Concrete Mix No. 5 (FABC) Coarse Aggregate Carbonate Rock

Ambient Temp. 64°F Surface Temp. 90°F Water Temp. 69°F

OUTFLOW METER TESTS
Time (Seconds)

No.	1	2	3	4	5	6	7	8
1	120.24	115.67	30.84	66.25	83.60	82.26	269.29	207.79
2	120.94	120.44	31.71	67.28	78.39	85.22	191.12	146.98
3	118.51	122.73	32.12	69.47	78.76	79.77	193.26	157.94
4	127.12	126.05	32.66	68.18	78.26	78.58	184.31	159.98
5	123.77	124.08	33.12	69.54	77.74	79.24	181.64	162.00
Avg.	123.77	121.79	32.09	68.14	79.35	81.01	203.92	166.94

BRITISH PORTABLE TESTS

No.	1	2	3	4	5	6	7	8
1	54	54	50	50	54	55	55	50
2	53	53	50	50	53	53	54	50
3	55	53	50	50	51	55	55	49
4	53	52	49	50	53	54	55	49
5	53	53	50	50	53	55	55	51
Avg.	53.6	53	49.8	50	52.8	54.4	54.8	49.8

SAND PATCH TESTS

Loc.	1	2	3	4	5	6	7	8
Texture Depth (inches)	.0047	.0047	.0150	.0175	.0120	.0128	.0074	.0080

SKID TESTS

	30 MPH	40 MPH	50 MPH
1	35	30	26
2	30	33	27
3	35	31	27
4	34	29	22
Avg.	33.5	30.75	25.5

OUTFLOW METER EVALUATION

Date May 4, 1978 Site No. 4

Route 33 Direction East Milepost 15.2 - 15.5

Year Placed 1971 Lanes (One-way) 2 AADT 18,900

Pave. Type Bituminous Concrete Mix No. 5 (FABC) Coarse Aggregate Carbonate Rock

Ambient Temp. 61°F Surface Temp. 65°F Water Temp. 67°F

OUTFLOW METER TESTS
Time (Seconds)

No.	1	2	3	4	5	6	7	8
1	11.92	13.47	14.54	10.84	9.20	9.66	9.85	9.95
2	12.11	13.83	14.97	11.11	9.24	10.12	10.00	11.39
3	12.12	13.94	15.25	11.13	9.29	9.77	10.14	11.57
4	12.29	13.94	15.60	11.64	9.29	10.57	10.38	11.69
5	12.35	14.03	15.69	11.49	9.35	10.47	10.54	11.80
Avg.	12.16	13.84	15.21	11.24	9.27	10.12	10.18	11.28

BRITISH PORTABLE TESTS

No.	1	2	3	4	5	6	7	8
1	48	50	55	51	55	53	46	52
2	48	52	54	51	54	52	45	53
3	49	50	55	51	54	53	45	52
4	50	49	54	51	52	51	46	52
5	50	50	55	51	52	51	46	51
Avg.	49	50.2	54.6	51	53.4	52	45.6	52

SAND PATCH TESTS

Loc.	1	2	3	4	5	6	7	8
Texture Depth (inches)	.0321	.0309	.0343	.0330	.0355	.0466	.0261	.0355

SKID TESTS

	30 MPH	40 MPH	50 MPH
1	34	34	31
2	35	34	29
3	36	33	29
4	37	33	29
Avg.	35.5	33.5	29.5

OUTFLOW METER EVALUATION

Date May 8, 1978 Site No. 5

Route I-295 Direction North Milepost 56.3 - 56.6

Year Placed 1974 Lanes (One-way) 3 AADT 12,400

Pave. Type Portland Cement Mix No. Coarse Aggregate Gravel

Ambient Temp. 59°F Surface Temp. 62°F Water Temp. 60°F

OUTFLOW METER TESTS
Time (Seconds)

No.	1	2	3	4	5	6	7	8
1	111.05	157.61	30.56	45.75	41.74	44.68	46.58	34.99
2	112.67	101.68	32.18	47.17	43.39	46.02	49.23	36.11
3	113.85	102.10	32.65	48.08	44.38	46.56	49.95	36.68
4	114.38	103.32	32.45	48.51	45.17	47.72	50.43	37.09
5	114.97	105.61	32.92	49.32	46.04	48.00	50.59	37.15
Avg.	113.38	102.06	32.15	47.77	44.14	46.60	49.36	36.40

BRITISH PORTABLE TESTS

No.	1	2	3	4	5	6	7	8
1	63	63	63	65	66	65	63	71
2	63	62	63	65	67	66	64	73
3	63	62	64	65	67	66	63	72
4	63	62	64	66	67	66	64	73
5	62	62	64	66	66	66	63	73
Avg.	62.8	62.2	63.6	65.4	66.6	65.8	63.4	72.4

SAND PATCH TESTS

Loc.	1	2	3	4	5	6	7	8
Texture Depth (inches)	.0137	.0115	.0068	.0154	.0133	.0115	.0219	.0214

SKID TESTS

	30 MPH	40 MPH	50 MPH
1	55	50	44
2	57	51	44
3	64	50	49
4	58	52	49
Avg.	58.5	50.75	46.5

OUTFLOW METER EVALUATION

Date May 10, 1978 Site No. 6

Route 1 Direction North Milepost 4.5 - 4.8

Year Placed 1975 Lanes (One-way) 2 AADT 17,000

Pave. Type Bituminous Concrete Mix No. 5 (FABC) Coarse Aggregate Trap Rock

Ambient Temp. 65°F Surface Temp. 72°F Water Temp. 69°F

OUTFLOW METER TESTS
Time (Seconds)

No.	1	2	3	4	5	6	7	8
1	18.33	21.14	08.90	24.88	16.02	17.97	34.94	18.60
2	18.81	21.82	09.12	24.45	16.56	18.34	35.62	19.13
3	19.31	22.30	09.20	24.55	16.90	18.81	36.65	19.64
4	19.49	22.87	09.27	24.73	17.16	19.29	37.14	20.10
5	19.62	23.09	09.32	25.14	17.31	19.31	37.34	20.35
Avg.	19.11	22.24	9.16	24.75	16.79	18.74	36.34	19.56

BRITISH PORTABLE TESTS

No.	1	2	3	4	5	6	7	8
1	65	69	66	63	66	65	66	65
2	66	67	66	63	65	65	66	65
3	63	67	65	63	67	65	66	66
4	64	68	65	63	65	65	66	66
5	65	68	65	63	67	65	67	65
Avg.	64.6	67.8	65.4	63	66	65	66.2	65.4

SAND PATCH TESTS

Loc.	1	2	3	4	5	6	7	8
Texture Depth (inches)	.0188	.0223	.0184	.0163	.0239	.0278	.0175	.0193

SKID TESTS

	30 MPH	40 MPH	50 MPH
1	64	52	48
2	65	55	50
3	60	52	49
4	53	49	43
Avg.	60.5	52	47.5

OUTFLOW METER EVALUATION

Date October 2, 1978 Site No. 1

Route I-295 Direction South Milepost 70.5 - 70.2

Year Placed 1974 Lanes (One-way) 3 AADT 27,500

Pave. Type Bituminous Concrete Mix No. 5 (FABC) Coarse Aggregate Trap Rock

Ambient Temp. 68°F Surface Temp. 71°F Water Temp. 68°F

OUTFLOW METER TESTS
Time (Seconds)

No.	1	2	3	4	5	6	7	8
1	26.22	20.80	10.94	24.82	20.59	24.09	12.04	34.13
2	26.62	21.54	11.42	26.60	21.69	25.06	12.32	36.41
3	27.36	22.09	11.91	27.41	22.31	25.91	12.70	37.74
4	27.63	22.09	11.84	27.61	23.19	26.81	12.85	38.41
5	28.03	22.40	11.94	27.46	23.95	26.88	13.08	39.06
Avg.	27.18	21.78	11.61	26.78	22.35	25.75	12.60	37.15

BRITISH PORTABLE TESTS

No.	1	2	3	4	5	6	7	8
1	60	61	59	59	61	62	62	60
2	60	60	58	59	61	62	61	59
3	61	60	58	60	61	62	61	60
4	60	61	58	60	62	62	62	60
5	60	61	59	60	62	60	61	61
Avg.	60.2	60.6	58.4	59.6	61.4	61.6	61.4	60.0

SAND PATCH TESTS

Loc.	1	2	3	4	5	6	7	8
Texture Depth (inches)	.0202	.0248	.0269	.0269	.0269	.0273	.0252	.0150

SKID TESTS

	30 MPH	40 MPH	50 MPH
1	45	37	33
2	45	39	37
3	45	37	31
4	45	39	34
Avg.	45.0	38.0	33.7

OUTFLOW METER EVALUATION

Date October 2, 1978 Site No. 2

Route 31 Direction North Milepost 4.2 - 4.5

Year Placed 1976 Lanes (One-way) 2 AADT 11,900

Pave. Type Bituminous Concrete Mix No. 4 (MABC) Coarse Aggregate Crushed Gravel

Ambient Temp. 66°F Surface Temp. 69°F Water Temp. 68°F

OUTFLOW METER TESTS
Time (Seconds)

No.	1	2	3	4	5	6	7	8
1	9.20	12.58	8.67	9.76	12.86	16.92	8.16	7.90
2	9.49	12.87	8.83	9.87	12.99	17.42	8.27	8.21
3	9.60	13.10	8.91	10.02	13.10	17.41	8.39	8.32
4	9.67	13.31	9.04	10.01	13.17	17.44	8.39	8.25
5	9.72	13.34	9.05	10.08	13.28	17.47	8.46	8.32
Avg.	9.54	13.04	8.90	9.95	13.08	17.33	8.33	8.20

BRITISH PORTABLE TESTS

No.	1	2	3	4	5	6	7	8
1	73	69	62	68	73	70	73	66
2	72	67	60	68	72	70	72	65
3	73	67	59	67	73	73	71	66
4	72	67	59	67	73	71	72	66
5	71	67	59	67	73	69	72	66
Avg.	72.2	67.4	59.8	67.4	72.8	70.6	72.0	65.8

SAND PATCH TESTS

Loc.	1	2	3	4	5	6	7	8
Texture Depth (inches)	.0330	.0325	.0338	.0287	.0210	.0107	.0343	.0412

SKID TESTS

	30 MPH	40 MPH	50 MPH
1	58	49	45
2	60	53	47
3	56	49	44
4	60	54	47
Avg.	58.5	51.25	45.75

OUTFLOW METER EVALUATION

Date October 3, 1978 Site No. 3

Route 206 Direction South Milepost 37.1 - 36.8

Year Placed 1971 Lanes (One-way) 2 AADT 30,000

Pave. Type Bituminous Concrete Mix No. 5 (FABC) Coarse Aggregate Carbonate Rock

Ambient Temp. 69°F Surface Temp. 76°F Water Temp. 69°F

OUTFLOW METER TESTS
Time (Seconds)

No.	1	2	3	4	5	6	7	8
1	250	250	74.92	96.34	21.22	250	134.74	250
2			77.22	99.86	22.09		135.57	
3			79.05	102.77	22.56		140.71	
4			79.81	103.03	22.65		140.52	
5			81.38	104.91	22.97		140.27	
Avg.			78.48	101.38	22.30		138.36	

BRITISH PORTABLE TESTS

No.	1	2	3	4	5	6	7	8
1	56	53	51	51	54	54	56	56
2	56	53	53	50	55	54	58	57
3	56	53	53	52	54	53	58	57
4	57	53	53	51	53	56	57	57
5	56	53	53	52	53	55	57	57
Avg.	56.2	53.0	52.6	51.2	53.8	54.4	57.2	56.8

SAND PATCH TESTS

Loc.	1	2	3	4	5	6	7	8
Texture Depth (inches)	.0000	.0000	.0111	.0291	.0146	.0021	.0000	.0133

SKID TESTS

	30 MPH	40 MPH	50 MPH
1	36	32	28
2	34	31	28
3	37	32	30
4	35	33	29
Avg.	35.5	32.0	28.75

OUTFLOW METER EVALUATION

Date October 11, 1978 Site No. 4

Route 33 Direction East Milepost 15.2 - 15.5

Year Placed 1971 Lanes (One-way) 2 AADT 18,900

Pave. Type Bituminous Concrete Mix No. 5 (FABC) Coarse Aggregate Carbonate Rock

Ambient Temp. 68°F Surface Temp. 66°F Water Temp. 69°F

OUTFLOW METER TESTS
Time (Seconds)

No.	1	2	3	4	5	6	7	8
1	9.05	13.11	10.05	9.33	6.96	5.93	12.30	11.60
2	9.45	13.53	10.42	9.97	7.06	5.91	12.78	11.98
3	9.58	13.89	10.70	10.24	7.13	6.05	12.94	12.24
4	9.70	14.08	10.92	10.45	7.25	6.19	12.99	12.49
5	9.76	14.14	11.05	10.73	7.36	6.12	13.10	12.74
Avg.	9.51	13.75	10.63	10.14	7.15	6.04	12.82	12.21

BRITISH PORTABLE TESTS

No.	1	2	3	4	5	6	7	8
1	48	53	55	54	51	53	53	55
2	48	53	55	55	51	52	53	55
3	47	52	55	55	52	52	53	56
4	49	52	55	54	51	51	53	57
5	49	51	56	54	50	51	54	56
Avg.	48.2	52.2	55.2	54.4	51.0	51.8	53.2	55.8

SAND PATCH TESTS

Loc.	1	2	3	4	5	6	7	8
Texture Depth (inches)	.0235	.0273	.0167	.0158	.0334	.0175	.0386	.0355

SKID TESTS

	30 MPH	40 MPH	50 MPH
1	34	32	28
2	35	32	28
3	36	34	27
4	35	29	24
Avg.	35.0	31.75	26.75

OUTFLOW METER EVALUATION

Date October 3, 1978 Site No. 5

Route I-295 Direction North Milepost 56.3 - 56.6

Year Placed 1974 Lanes (One-way) 3 AADT 12,400

Pave. Type Portland Cement Mix No. -- Coarse Aggregate Gravel

Ambient Temp. 74°F Surface Temp. 80°F Water Temp. 70°F

OUTFLOW METER TESTS
Time (Seconds)

No.	1	2	3	4	5	6	7	8
1	163.38	233.77	99.93	76.21	57.33	36.54	55.79	55.69
2	121.29	205.64	100.46	78.24	58.41	37.45	62.01	55.57
3	119.69	179.89	100.19	80.91	59.40	38.28	64.13	57.02
4	116.98	187.76	101.74	81.69	57.80	36.11	67.56	62.76
5	108.45	186.66	103.19	83.69	55.99	37.54	63.63	66.12
Avg.	125.96	198.74	101.10	80.15	57.79	37.18	62.62	59.43

BRITISH PORTABLE TESTS

No.	1	2	3	4	5	6	7	8
1	64	64	62	62	62	64	60	60
2	64	62	61	63	62	64	59	60
3	63	62	61	61	61	63	59	61
4	63	62	61	63	62	63	60	60
5	63	63	61	62	61	63	60	61
Avg.	63.4	62.6	61.2	62.2	61.6	63.4	59.6	60.4

SAND PATCH TESTS

Loc.	1	2	3	4	5	6	7	8
Texture Depth (inches)	.0057	.0090	.0000	.0015	.0120	.0137	.0000	.0047

SKID TESTS

	30 MPH	40 MPH	50 MPH
1	53	43	39
2	53	43	43
3	49	46	44
4	49	45	43
Avg.	51.0	44.25	42.25

OUTFLOW METER EVALUATION

Date October 5, 1978 Site No. 6

Route 1 Direction North Milepost 4.5 - 4.8

Year Placed 1975 Lanes (One-way) 2 AADT 17,000

Pave. Type Bituminous Concrete Mix No. 5 (FABC) Coarse Aggregate Trap Rock

Ambient Temp. 62°F Surface Temp. 64°F Water Temp. 66°F

OUTFLOW METER TESTS
Time (Seconds)

No.	1	2	3	4	5	6	7	8
1	13.14	29.65	12.57	23.28	18.43	19.66	12.60	11.22
2	13.68	32.60	12.68	25.49	19.58	20.19	12.91	11.37
3	14.00	34.52	14.28	25.85	20.02	20.93	12.90	11.52
4	12.88	35.20	14.64	26.73	20.28	21.04	13.04	11.78
5	14.61	35.17	15.05	26.70	20.49	21.29	13.16	12.09
Avg.	13.66	33.43	13.84	25.61	19.76	20.62	12.92	11.60

BRITISH PORTABLE TESTS

No.	1	2	3	4	5	6	7	8
1	70	64	70	68	71	72	67	68
2	69	64	69	69	71	72	68	68
3	68	64	70	68	70	73	68	67
4	69	64	69	69	70	73	68	68
5	69	64	69	69	71	72	69	69
Avg.	69.0	64.0	69.4	68.6	70.6	72.4	68.0	68.0

SAND PATCH TESTS

Loc.	1	2	3	4	5	6	7	8
Texture Depth (inches)	.0261	.0219	.0295	.0243	.0210	.0273	.0231	.0202

SKID TESTS

	30 MPH	40 MPH	50 MPH
1	52	51	44
2	56	52	42
3	54	46	43
4	53	45	39
Avg.	53.75	48.5	42.0

OUTFLOW METER EVALUATION

Date October 12, 1978 Site No. A

Route 37 Direction East Milepost 32.0

Year Placed Nov. 1975 Lanes (One-way) 1 AADT 11,500

Pave. Type OGFC Mix No. -- Coarse Aggregate Crushed Gravel

Ambient Temp. 75°F Surface Temp. 82°F Water Temp. 78°F

OUTFLOW METER TESTS
Time (Seconds)

No.	1	2	3
1	4.09	4.88	3.66
2	4.31	4.89	3.68
3	4.33	5.03	3.75
4	4.31	4.95	3.80
5	4.32	4.95	3.75
Avg.	4.27	4.94	3.73

BRITISH PORTABLE TESTS

No.	1	2	3
1	70	71	63
2	71	72	63
3	71	74	63
4	71	74	63
5	71	75	63
Avg.	70.8	73.2	63

SAND PATCH TESTS

Loc.	1	2	3
Texture Depth (inches)	.0518	.0725	.0746

SKID TESTS

	30 MPH	40 MPH	50 MPH
1	57	54	54
2	58	53	52
3	60	53	52
Avg.	58.3	53.3	52.7

OUTFLOW METER EVALUATION

Date October 12, 1978 Site No. B

Route 37 Direction East Milepost 33.2

Year Placed Aug. 1977 Lanes (One-way) 1 AADT 11,500

Pave. Type OGFC Mix No. -- Coarse Aggregate

Ambient Temp. 75°F Surface Temp. 82°F Water Temp. 78°F

OUTFLOW METER TESTS
Time (Seconds)

No.	1	2	3
1	5.86	5.99	3.91
2	5.73	5.86	4.02
3	5.65	5.81	3.92
4	5.70	5.75	3.96
5	5.89	5.82	4.14
Avg.	5.77	5.85	3.99

BRITISH PORTABLE TESTS

No.	1	2	3
1	55	53	56
2	54	54	57
3	55	55	57
4	55	55	57
5	55	55	58
Avg.	54.8	54.4	57.0

SAND PATCH TESTS

Loc.	1	2	3
Texture Depth (inches)	.0455	.0715	.0481

SKID TESTS

	30 MPH	40 MPH	50 MPH
1	48	47	46
2	51	47	45
3	48	46	45
Avg.	49.0	46.7	45.3

OUTFLOW METER EVALUATION

Date October 12, 1978 Site No. C

Route 37 Direction East Milepost 34.7

Year Placed 1978 Lanes (One-way) 1 AADT 11,500

Pave. Type OGFC Mix No. -- Coarse Aggregate

Ambient Temp. 75°F Surface Temp. 82°F Water Temp. 78°F

OUTFLOW METER TESTS
Time (Seconds)

No.	1	2	3
1	4.57	3.98	3.98
2	4.62	4.18	4.18
3	4.62	4.24	4.23
4	4.56	4.23	4.37
5	4.65	4.28	4.28
Avg.	4.60	4.18	4.21

BRITISH PORTABLE TESTS

No.	1	2	3
1	56	53	54
2	57	53	55
3	57	53	54
4	56	54	54
5	57	54	54
Avg.	56.6	53.4	54.2

SAND PATCH TESTS

Loc.	1	2	3
Texture Depth (inches)	.0627	.0940	.0696

SKID TESTS

	30 MPH	40 MPH	50 MPH
1	54	47	45
2	53	47	45
3.	51	48	45
Avg.	52.7	47.3	45.0